NUTRIENT DYNAMICS OF KAPPIL ESTUARINE SYSTEM, KERALA.

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ABSTRACT
Nutrient parameters such as NO$_2$, NO$_3$, PO$_4$ and SiO$_4$ of Kappil Kayal of Thiruvananthapuram district of Kerala state was monitored for a period of one year. Spatial variations in nutrient loading were noticed between months. Maximum concentration of NO$_2$, NO$_3$ and SiO$_4$ was observed during monsoon months. Phosphate gained maximum values during summer months. Among the 6 sampling stations, 3 stations were found to be nutrient rich throughout the study period.

Keywords: Nutrients, Edava Nadayara Kayal

INTRODUCTION
Estuaries are dynamic ecotones providing habitat for both freshwater and marine organisms. As these zones are rich in nutrients, estuaries are highly productive and act as a feeding ground for many aquatic lives. Estuaries are unique spots of biodiversity. They provide habitat for anadromous and catadromous fishes. They are habitually depicted as having low salinities, shallow depths, high turbidity, enough nutrients and rich in productivity (Feebarani; 2009). Estuaries are one of the most heavily utilized zones in our Earth. They are often utilized for fishing, aquaculture, recreation, transportation and tourism. Studies on the Hydrological and ecological features of estuaries are very important as these zones are enriched with nutrients and are the most productive ecosystems of the Earth. Water bodies like ponds, rivers, rivulets, estuaries and oceans provide habitat for various aquatic organisms (Ramachandra and Solanki; 2007). India is bestowed with a large network of water bodies, connecting the inland fresh water systems. In India, there are about 113 major and minor estuaries which are connected to a combined river length of 45,000 km. (Ramesh and Purvaj, 2009).

As a result of human interference, estuaries are being subjected to serious deterioration and causes ecological imbalance (Nair; 1995). Estuarine systems when exposed to pollutants will be under stress, leading to vicissitudes in the physico-chemical attributes of aquatic systems. Estuaries with freshwater inflow and tidal variations provide highly fluctuating environmental conditions and the organisms exhibit homeostatic mechanisms to cope with such conditions (Elliot and Quintino, 2007). Any factor that perturbs this state is found to inflict unpropitious effect on organisms and hence act as stressors. By receiving waste materials and sewage from nearby sources, aquatic environments are usually susceptible to pollution. Estuaries, the tidal mouth of rivers which connects river/rivulets are no exception (Lipp et al., 2001; Keser et al., 2005 and Kessarkar et al., 2009).

Primary productivity is an important factor in assessing the fertility of a water body (Feebarani, 2009) and is well depended on the available nutrients. The primary productivity of a tropical estuary is always depend on the availability of nutrients (Renjith, 2004). Usually estuarine environments are enriched with nutrients through many sources. Bemer and Bemer (1987) documented a number of nutrient sources for phytoplankton growth in the surface water. Nutrients are essential for the growth and well-being of primary and secondary producers in an estuary (Nair, 1995). The supply of fresh nutrients and their effective regeneration is an important factor determining the productivity of an aquatic ecosystem (Resmi, 2004). Physical, geological, chemical and biological processes are a controlling factor of distribution and variation of nutrients in estuarine systems (Aston, 1980).

MATERIALS AND METHODS
Kappil backwater is a shallow brackish water system, which lies between 8°77'75.90" to 8°78'88.13"N latitudes and 76°67'58.48" to 76°67'68.83"E longitudes. The main fresh water inflows of this back water system is a small river named Ayiroor puzha. Unlike the other larger river systems of Kerala, the 17 km. long Ayiroor puzha originates at Navayikulam, a midland part of Kerala and flows to the Edava Nadayara kayal. Ithikkara River, which originate from the Western Ghats and flows down to the Parvur Kayal is also a contributing factor for the ecology of Kappil backwaters. The lake falls in the boundary of Kollam and Thiruvananthapuram districts. It is connected to Paravur kayal by Maniyamkulam canal. It is also connected to the Varkala Hariharapuram kayal. A natural pozhi (bar mouth) is present, which connects Kappil backwaters to the Arabian
sea. During summer months a sand bar is formed in between the lake and sea. Two boat clubs operated by the district tourism promotion councils of Kollam and Thiruvananthapuram districts are functioning, which facilitates boating for tourists. Some parts of this backwater are widely used for husk retting. These areas are apparently polluted and secrete a foul smell. This backwater is often used for fishing, retting, recreation, aquaculture etc.

A detailed investigation on the geographical and ecological aspects was carried out ahead of fixing sampling locations. Accordingly, six stations were fixed for sample collection. These are namely I. Kappil pozhi, II. Kappil bridge, III. Kilimukkam kayal, IV. Maniyamkulam canal mouth, V. Edava Nadayara kayal and VI. Kottamoola. Monthly collection of water samples were carried out from all the 6 stations from June 2015 to May 2016. Samples were analysed immediately for nutrients parameters. All the analyses were carried out following standard methods (APHA, 2012).

RESULTS AND DISCUSSION

All nutrient parameters except phosphate showed maximum values during monsoon months and it might be due to the influence of surface runoff from the surrounding land and heavy river discharge. However phosphate was observed in maximum concentration during summer months.

The distribution of nitrite in water samples of Paravur Thekke kayal ranged from 0.41 to 1.02 mg/l (Figure 1). The highest value was recorded in station IV during June 2015. Highest average monthly mean value of nitrite was also recorded in June 2015 (0.92±0.07) and lowest in February 2016 (0.60±0.04). Highest annual mean value was recorded in station IV (0.84±0.11) and lowest was recorded at station III (0.70±0.12). Highest concentration of nutrients in estuarine water during monsoon months was reported by Bhat (2003) in Aghanasini estuary, Kumta. Values of this chemical concentrate showed decreasing tendency by the end of post-monsoon and recorded lower values during summer months. It may

<p>| Table 1. Correlation coefficient between nutrients |</p>
<table>
<thead>
<tr>
<th>NO2</th>
<th>NO3</th>
<th>PO4</th>
<th>SiO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO3</td>
<td>0.752**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PO4</td>
<td>0.633**</td>
<td>0.583**</td>
<td>1</td>
</tr>
<tr>
<td>SiO4</td>
<td>0.556**</td>
<td>0.458**</td>
<td>0.266*</td>
</tr>
</tbody>
</table>
be due to the intake by planktons and other microorganisms (Renjith et al., 2004). The average annual and monthly mean value of nitrate was recorded below 1 mg/l during the study period. Nitrite content was high during rainy season and tends to lower levels towards reaching summer months and it may be due to the lack of fresh water inflow. The same condition was noticed in Thengapattanam estuary by Anitha (2014). Higher values in monsoon and lower values in summer season were also reported by Karuppiah et al. (2011), Prabu et al. (2008) and Manikannan et al. (2011). Nitrite was found positively correlated to nitrate \( (r = 0.752) \), phosphate \( (r = 0.633) \) and silicate \( (r = 0.556) \) (Table 1). Generally nitrate content in the water samples of Kappil backwaters ranged between 1.02 mg/l to 5.02 mg/l (Figure 2). Maximum value was recorded in station IV during May 2016 and minimum value was at station III during December 2015. Highest annual mean value was also recorded at station IV \( (4.27\pm0.55) \) and lowest was at station III \( (2.60\pm0.97) \). Likewise the distribution of nitrites, nitrates also showed hike in rainy season. Highest monthly mean value of nitrate was found during June 2015 \( (4.28\pm0.47) \) and lowest during December 2015 \( (2.16\pm1.11) \). Monsoon season recorded higher values in comparison with summer months. This means that the backwater gets heavy nitrate concentration from the nearby inflows. Water discharge from agriculture lands, such as paddy fields and coconut plantations also might have contributed to higher nitrate values.

Maximum nitrate values during monsoon and minimum values during pre-monsoon were reported by Soundarapandian et al., (2009) in Uppanar estuary, Cuddalore. Similar conditions were also reported by Haridevi (2013) and Martin et al. (2008) from Cochin backwaters. Domestic sewages and organic pollutants also have an effect on nitrate values. Station IV is a canal mouth, which connects Kappil backwaters with Paravoor kayal and is a dumping yard for various organic and inorganic waste materials. Decomposition of such organic waste materials might result in higher nitrate values in station IV. Formation of nitrate through decomposition of organic waste materials was reported in Pennar estuary by Ravaniah et al. (2010). Nitrate values were found positively correlated to nitrite \( (r = 0.752) \), phosphate \( (r = 0.583) \), silicate \( (r = 0.458) \) (Table 1).

The observed variation of phosphate in Kappil backwaters ranged from 0.62 mg/l to 1.27 mg/l (Figure 3). Maximum value was observed in station VI during May 2016 and minimum value was found in station V during August 2015. Highest monthly mean value of phosphate was recorded both in June 2015 \( (1.10\pm0.10) \) and lowest value was found during December 2015 \( (0.74\pm0.12) \). Highest average annual mean value of phosphate was found at station IV \( (1.01\pm0.16) \) and lowest was recorded at station V \( (0.82\pm0.16) \). Annual average mean value of phosphate was seen more or less similar in all stations. However slightly high concentration of phosphate values were recorded at station IV and VI. This may be due to the heavy retting activities in these stations. Maximum values were found during pre-monsoon season in all stations. In all stations phosphate values showed an increasing tendency by the end of post-monsoon season. Increasing tendency of phosphate values during summer months may be due to the exchange of phosphorous between sediments and overlaying water. The low consumption of planktons and precipitating condition might have contributed to higher phosphate values during summer season. Such a condition was also noticed in the Edava Nadayara kayal by Madhukumar (1996). Phosphate values were found positively correlated to nitrite \( (r = 0.633) \), nitrate \( (r = 0.583) \) and silicate \( (r = 0.266) \) (Table 1).

Highest concentration of silicate was measured at station IV \( (2.21\text{mg/l}) \) (Figure 4) during June 2015 and lowest was measured at station III \( (0.85 \text{mg/l}) \) during August 2015. Monthly mean value was also high during June 2015 \( (2.00\pm0.17) \) and low during February 2016 \( (1.26\pm0.13) \). Average annual mean value was found high in station IV \( (1.75\pm0.25) \) and low at station VI \( (1.27\pm0.28) \). Silicate is an important nutrient for the plankton’s growth. It is also useful for the skeleton formation of diatoms and radiolarians (Kannappan, 2015). In the present analysis, it was found that silicate content was high during monsoon months and it means that the backwater gets maximum silicate from freshwater inflows. This is in agreement with the findings reported from Cochin backwaters by Martin et al. (2008, 2013). Similar finding was also reported by Alkershi (2002). He also reported the importance of silicate in planktonic growth. Silicate values were found positively correlated to nitrite \( (r = 0.556) \), nitrate \( (r = 0.458) \) and phosphate \( (r = 0.266) \) (Table 1).

**CONCLUSION**

Nitrite, nitrate and silicate gained maximum values during the monsoon season. But phosphate gained maximum values during pre-monsoon season. Slight increase in nutrient parameters was also observed from the beginning of summer months and it might be due to the decomposition of organic matter brought in during southwest and northeast monsoon to these aquatic environments. As stated earlier, station I is a canal mouth and was found polluted with organic and inorganic waste materials. It was also noticed that some drainage systems from nearby areas carrying large amount of pollutants to the canal and these things might have resulted in the deterioration in water quality. Heavy retting practices in station VI was also found to be a contributing factor for the distribution nutrients.

**Acknowledgements:** The first author is thankful to the Heads of Departments of Zoology, Botany and Chemistry, NSS College, Pandalam. The second author express sincere gratitude to the University of Kerala for the award of Junior Research Fellowship and both are indebted to the Director, Survey of India, Poonkulam, Thiruvananthapuram for providing map and to the Director of meteorological department, Thiruvananthanpuram for providing rainfall data.
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